

SECTION 33 20 00.01 00

WATER-SUPPLY WELL CONSTRUCTION, DEVELOPMENT AND PUMPING TESTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA A100	(2006; Errata 2007) Water Wells
AWWA B300	(2010; Addenda 2011) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C654	(2013) Disinfection of Wells

ASTM INTERNATIONAL (ASTM)

ASTM A312/A312M	(2015) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D2487	(2011) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2488	(2009a) Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4750	(1987; R 2001) Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)
ASTM D5521/D5521M	(2013) Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers

1.2 SYSTEM DESCRIPTION

The drilling of a **AM#9...minimum of 5...AM#9** pilot **AM#9...holes...AM#9** will be necessary to collect soil samples between 150 feet below the ground surface and the bottom of the borehole at 300 feet. **AM#9...A pilot hole is to be drilled a maximum of 10 feet from each of the 8 proposed water supply wells....AM#9** The soil samples will be submitted to a laboratory for analysis of grain-size.

A 36-inch diameter borehole is to be drilled to a depth of 30 feet bls at each location. Once drilled, 30-inch diameter temporary steel casing will

be installed to a depth of 30-feet bls. A 30-inch diameter borehole will be drilled from 30 to 300 feet. Each well shall be installed to 300 feet deep.

Each well shall consist of 24-inch diameter stainless steel well casing and 24-inch diameter stainless steel 80-slot well screen.

A sanitary well seal shall be installed in the annulus between the well casing and the borehole wall extending from 15 to 30 feet below ground surface.

A Typical Water-Supply Well Detail is included on Sheet Reference Number D-900501B, Water Supply Wells Details. Fabrication and delivery of well screen is expected to take several weeks. Once all materials of construction are on site, the water-supply well shall be constructed in the final borehole.

Each well shall be located where directed by the Contracting Officer, and be constructed in accordance with these specifications. Each well shall be installed to prevent aquifer contamination by the drilling operation and equipment, intra- and inter-aquifer contamination, and vertical seepage of surface water adjacent to the well into the subsurface, especially the well intake zone. The management of water will be necessary as the site is level and other work and contractors will be working in the area.

Drilling challenges encountered during the geotechnical site investigations and aquifer pump test (Golder Associates, January 5, 2016), to include cobbles, boulders, and heaving soil below the groundwater, must be anticipated during well installation. Refer to the Aquifer Pump Test Geotechnical Data Report (Golder, 2016) for a discussion of well drilling challenges. Copies of the Golder reports as well as other pertinent data are provided as part of the specification package.

1.2.1 Notification

The Contracting Officer shall be notified 14 (fourteen) days prior to drilling. Before beginning work, the Contractor shall be responsible for contacting the Alaska Department of Environmental Conservation, State of Alaska Division of Environmental Health, Alaska Department of Natural Resources, and local health department to notify these agencies of the type and location of wells to be constructed, the method of construction and anticipated schedule for construction of the wells.

1.2.2 Abandonment of Wells

If the Contractor fails to construct a well of the required capacity, or if the well is abandoned because of loss of tools, or for any other cause, it is the Contractor's responsibility to notify the appropriate agencies of the well abandonment, as necessary and as specified in paragraph WELL OR PILOT HOLE ABANDONMENT.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submittals with an "S" designation following the "G" are for inclusion in the Sustainability Notebook, in conformance to Section 01 33 29.01 00 SUSTAINABILITY REPORTING. Other designations following the "G" designation identify the office that will review the submittal for the

Government. Submit the following in accordance with Section 01 33 00.01 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Diagrams; G JC Plan Section D-900501B

SD-03 Product Data

Well Installation Plan; G JC

Drilling Fluids; G JC

Backfill Materials; G JC

Stainless Steel Well Screen; G JC

Stainless Steel Well Casing; G JC

Clean Fill; G JC

Qualifications; G JC

Well-Screen Submittal; G JC

Well Material; G JC

Site Conditions; G JC

SD-06 Test Reports

Plumbness and Alignment; G J

Quality of Water; G J

Well Development Records; G J

Pumping Test Records; G J

Video Inspection; G J

As-Built Drawings; G J

Abandonment Records; G J

Project Photographs; G J

Water Source; G J

Performance Tests; G JC

SD-07 Certificates

Well Casings; G J

Drilling mud; G J

Well Screens; G J

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

To demonstrate his Qualifications to perform the work specified, the Contractor shall submit the following documentation with his bid:

1.4.1.1 Contractor License/Certification

The Contractor shall be properly licensed and/or certified in the State of Alaska to install potable water-supply wells of the type specified. The Contractor shall submit a copy of his license and/or certification.

1.4.1.2 Contractor Experience Record

The Contractor shall submit a complete list of water-supply wells he has installed in unconsolidated aquifers in the State of Alaska in the last two years, including the site location, the date of installation, the diameter and depth of the well, the well yield, and the type of drilling method. The Contractor shall submit a complete list of pumping tests conducted in the last two years, including the location, the diameter and depth of the well, the length of the pumping test and the pumping rate.

1.4.1.3 Well Driller Experience Record

The Contractor shall submit the name and experience record of each well driller. Well drillers engaged on the Project shall be experienced in the construction of water-supply wells of the type specified having satisfactorily constructed at least three (3) such wells in the last two years. Well drillers engaged on the Project shall be experienced in conducting continuous pumping tests of the type specified herein, having satisfactorily performed at least three (3) such pumping tests in the last two years.

1.4.1.4 Professional Engineer

The Contractor shall submit the name, experience record and certification of the Professional Engineer, properly licensed by the State of Alaska, who will supervise the construction and testing of the water supply wells.

The Professional Engineer shall perform the duties required by the State of Alaska during the drilling and installation of the water-supply wells and the pumping tests. After the wells are constructed and the pumping tests are completed, the Professional Engineer shall prepare and submit the reports and documentation required by the State of Alaska.

1.4.1.5 Proposed Approach for Well Construction

The Contractor shall submit a description of his overall approach for drilling boreholes and installing the proposed water-supply wells. This shall include the type and diameter of temporary casings to be used, pilot-hole and borehole diameters, proposed soil sampling methods, proposed drilling fluids, proposed means of installing well casings and well screens, proposed well sealants and installation, proposed methods for overcoming well drilling challenges, and proposed pumping test equipment and methodology.

1.4.2 Well Installation Plan

Submit a plan as specified herein describing the drilling methods, sampling, and well construction and well development 10 (ten) calendar days prior to beginning drilling operations. Mobilization activities may start prior to submittal of the plan. The plan shall be approved and signed by an experienced Professional Engineer as specified in paragraph QUALIFICATIONS. Incorporate the following requirements into the Contractor's Well Installation Plan and follow them in the field. The plan shall include, but shall not be limited to, a discussion of the following:

- a. Description of well drilling methods, methods to overcome well drilling challenges, and well installation procedures, including any pilot holes and temporary casing used, soil-sampling procedures, placement of seal materials, and soil/rock sample disposition.
- b. Description of well construction materials, including well screen, riser pipe, centralizers, bentonite or drilling mud, drilling water, cement, and well protective measures.
- c. The Contractor shall prepare a written Drilling Fluids Program, subject to the review and approval of the Contracting Officer. The Drilling Fluids Program shall describe the proposed additives to be used in the drilling fluid (for example, soda ash, bentonite, polymer); the proportions of these additives and method of mixing; and the proposed drilling fluid properties (pH, mud weight, fluid-loss, viscosity and calcium content). The Drilling Fluids Program shall also explain how the drilling fluids will work in harmony with the Contractor's drilling equipment with the overall goal of stabilizing the boreholes. The Drilling Fluids Program shall describe the additives to be used to break down the filter cake once the well screen is installed and well development commences. Finally, the Drilling Fluids Program shall include the name and experience record of the Drilling Fluids Engineer who will monitor the drilling fluids for optimal performance throughout the drilling and well-construction process.
- d. Within 10 days after receipt of Notice to Proceed, the Contractor shall submit for approval product data for: Stainless steel well casing and stainless steel well screens, and the products proposed for joining sections of well casing and screen (i.e. welding rods); drilling fluids and additives; backfill materials (processed sand and bentonite pellets); clean fill; well sealant to be placed between the well casing and the borehole wall; and, soil coring tools.
- e. Description of methods to be used to test for plumbness and alignment.
- f. Description of quality control procedures to be used for placement of seals in the boring, including depth measurements.
- g. Blank forms to be used for written borehole logs, installation diagrams of wells, well development records, well sampling data records, pumping test records, state well registration forms, and well abandonment records.
- h. Description of contamination prevention and well materials and equipment decontamination procedures.
- i. Description of protective cover, surface completion procedures, including any special design criteria/features relating to frost heave

prevention. The maximum frost penetration for the site shall be included in this description.

- j. Description of well development methods to be used.
- k. Description of water management methods, including any special design criteria/features relating to managing water from well drilling activities as well as pumping tests.
- l. List of applicable publications, including state and local regulations and standards.
- m. List of personnel assignments for this project, and personnel qualifications.
- n. Description of well abandonment procedures.
- o. Description of well capacity pumping testing techniques.

1.4.3 Qualifications

Submit personnel qualification documentation. A Professional Engineer with at least 3 (three) years of experience in soil and rock logging, and well installation, licensed in the state of Alaska, shall be on site and responsible for all borehole logging, drilling, well installation, developing and testing activities. The driller shall be licensed in the state of Alaska, according to the state requirements. Document a minimum of three years of well installation experience. The Contractor's staff shall include appropriate health and safety personnel as specified in Section 01 35 26.01 00 GOVERNMENTAL SAFETY REQUIREMENTS

1.4.4 Sampling

Soil samples shall be taken from a depth of approximately 150 to 300 feet at increments of five-feet or at any change in stratum. Samples shall be extracted from their in-situ environment in as minimally disturbed condition as technically practical. Samples shall be delivered to the Contracting Officer designated facility. Representative soil samples shall be tested for grain-size distribution by mechanical means (sieves down to the 0.003-inch size according to ASTM C136/C136M). Description and identification of soils shall be done in accordance with ASTM D2488. Laboratory classification of soils shall be done in accordance with ASTM D2487.

1.5 DELIVERY, STORAGE, AND HANDLING

Store and maintain well materials in a clean, uncontaminated condition throughout the course of the project.

1.6 SITE CONDITIONS

Access to each well site, including any utility clearance, permits, licenses, or other requirements and the payment thereof necessary for execution of the work, is the responsibility of the Contractor. Prior to mobilization, the Contractor shall visit each proposed well location to observe any condition that may hamper transporting equipment or personnel to the site. If clearing, or relocation is necessary, the Contractor, and the Contracting Officer shall agree on a suitable clearing, and/or the location of any required access road.

1.6.1 Soil and Groundwater Conditions

A description of existing subsurface conditions and drilling challenges experienced during geotechnical and aquifer pump test investigations are provided in the reports titled: Clear Air Force Station Long Range Discrimination Radar Geotechnical Data Report dated November 24 2015 and Aquifer Pump Test - Long Range Discrimination Radar dated January 5 2016, found in the Specification Appendix.

The Contractor must anticipate difficult drilling conditions with low drilling advancement rates through sand, gravel, cobbles, boulders, and heaving soil below the groundwater.

1.6.2 Other General Requirements

The Contractor shall coordinate all his work with the Contracting Officer.

The Contractor shall take all necessary precautions for the safety of employees on the work and comply with all applicable provisions of applicable safety laws and building codes to prevent accidents or injury to persons on, about, or adjacent to the premises where the work is being performed.

The Contractor shall comply with applicable licenses and permits related to environmental protection.

The Contractor shall coordinate with the Contracting Officer regarding setup at each drilling location and confine his activities to areas designated by the Contracting Officer.

The Contractor shall be fully informed of the conditions relating to construction and labor under which work will be or is now being performed and employ such methods and means in the carrying out of this work as will not cause any interruptions or interference with any other work at the Site.

The Contractor shall keep a copy of the Contract Documents at the Site of the work at all times while work is being performed.

The Contractor shall provide whatever additional equipment and manpower as may be necessary in order to complete the project.

The Contractor shall make all arrangements for and furnish at his own expense all telephone or other utility required for construction purposes.

1.7 PROTECTION OF WORK AND PROPERTY

The Contractor shall carefully protect all work so that no injury will come to it from water, frost, ice, accident or other cause. Any injury to the work shall be repaired at no expense to the Owner. The Contractor shall protect the Owner's property from injury or loss arising in connection with this Project and make good any damage, injury, or loss. The Contractor shall adequately protect adjacent and/or private property as provided by law and the Contract Documents.

The Contractor shall not release petroleum products to the environment. To this end, the Contractor shall furnish, install and maintain, for the life of the Project, secondary containment for all fuel stored on site. Secondary containment shall have a capacity to hold 150 percent of the

volume of the fuel containers. The Contractor shall leave no more than 5 gallons of fuel in any piece of equipment that is unattended overnight and/or over weekends. The Contractor shall furnish, place and maintain polyethylene sheeting of minimum 30-mil thickness under all equipment containing fuel or other hazardous materials. Polyethylene sheeting shall be placed in one piece; joining of separate pieces will not be acceptable. Non-stationary equipment shall be parked over the sheeting at all times when it is not in use. The Contractor shall discuss with the Contracting Officer in advance secondary containment of the fuel to be used during the pumping test.

1.8 VISIT TO THE SITE

Before mobilizing, the Contractor shall visit the proposed site, examine conditions and become thoroughly acquainted with the conditions for performing the work. The Contractor shall study the technical specifications, and compare the same with the information gathered during the examination of the Site, as no extra compensation will be authorized for extra work caused by unfamiliarity with the Site and/or specifications or the conditions peculiar to this Project.

1.9 CLEANUP

During the course of the work, the Contractor shall keep the Site in a clean and neat condition, and shall legally dispose of all residues resulting from the construction work and, at the conclusion of the work, remove and legally dispose of any surplus materials and any other refuse remaining from the construction operations. At the conclusion of the Project, the Contractor shall remove temporary roadways, and leave the entire Site of the work in a neat and orderly condition, subject to the approval of the Contracting Officer.

1.10 WATER SUPPLY FOR CONSTRUCTION PURPOSES

Water needed for construction purposes, including water needed for drilling fluids, well sealants and other purposes, is the sole responsibility of the Contractor. It is the Contractor's responsibility to identify the source, obtain the water, and ensure the water quality meets the requirements for the prescribed use. The Contractor shall be responsible for taking water quality samples and providing results to the Contracting Officer for approval prior to any water use.

PART 2 PRODUCTS

2.1 WELL MATERIALS - GENERAL

All casing, screen, and other well material shall be of compatible materials to prevent galvanic reaction between components of the completed well.

The Contractor shall provide submittals for: the Well Installation Plan, Drilling Fluids, Backfill Materials, Stainless Steel Well Screen, Stainless Steel Well Casing, Well Sealant, clean Fill, Qualifications, Well-Screen Submittal, Well Materials, and Site Conditions.

2.2 DRILLING FLUIDS

The overall goals of the drilling fluids are as follows:

- a. To maintain borehole stability during drilling;
- b. To balance the need for borehole stability with the need to minimize intrusion of the mud into the formation;
- c. To remove the mud cake fully from the borehole wall during well development to maximize well efficiency.

In addition to these overall goals:

The drilling fluids selected shall be water-based and suitable for use in the drilling of water-supply wells of the type specified herein.

The drilling fluids selected shall be suitable for maintaining the stability of boreholes of the depth and diameter specified herein, and preventing fluid loss.

The drilling fluids selected shall be suitable for removing all soil cuttings from around the drill bit and lifting them out of the borehole into the mud tubs.

The drilling fluids selected shall allow soil cuttings to settle out in the mud tubs.

The Contractor shall submit for approval product data and the name of the supplier for the proposed drilling fluids and additives within 10 days of receipt of the Notice to Proceed.

2.3 WELL CASINGS

Temporary casings shall be steel with a minimum wall thickness of 6.4 mm (1/4-inch), and suitable for butt welding, if necessary. Temporary casings that are damaged, dented, out-of-round, crimped, or otherwise unsuitable shall be rejected by the Contracting Officer.

Steel guides of a design approved by Contracting Officer shall be used to maintain proper spacing between the walls of all temporary steel casings.

2.4 PERMANENT STAINLESS STEEL WELL CASING

Permanent well casing shall be new Type 304 stainless steel, with an inside diameter of 24-inches and a wall thickness of not less than 3/8-inch. Well casing shall meet the requirements of ASTM A312/A312M, or Contracting Officer approved equal, and shall be compatible with the stainless steel well screen.

All permanent casing shall be joined by butt welding.

The Contractor shall submit for approval product data and the name of the supplier for the proposed stainless steel well casing within 10 days of receipt of the Notice to Proceed.

2.5 STAINLESS STEEL WELL SCREEN AND PLATE

Well screen shall be 24-inch diameter, 80-slot, Type 304 stainless steel of the continuous slot, wire wound design meeting the requirements of AWWA A100. Screen shall be fabricated by circumferentially wrapping a 3/16-inch, triangularly shaped wire around a circular array of internal rods. The wire configuration must produce inlet slots with sharp outer edges. The

slots shall widen inward so as to minimize clogging. Each juncture between the horizontal wire and the vertical rods shall be fusion welded under water by the electrical resistance method. The screen length shall be determined through soil sampling.

Well screen shall be selected so that the average entrance velocity does not exceed 0.10 feet per second at the design flow rate of 2,200 gpm.

The bottom plate of the well screen plate shall be Type 304 stainless steel, 1/4-inch thick continuously welded to the bottom of the well screen.

Perforated and louvered type well screens are not acceptable.

The Contractor shall submit for approval product data and the name of the supplier for the proposed stainless steel well screens within 10 days of receipt of the Notice to Proceed.

2.6 CLEAN FILL

The drilling contractor can retract the temporary casing allowing the formation to collapse around the permanent well casing.

If necessary, clean fill may be used as backfill. Suitable fill materials consist of sand and gravel aquifer material drilled and approved clean or sand and gravel from permitted off-site sources that meets all of the specified requirements for its intended use and is approved by the Contracting Officer.

Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat.
2. Vegetation, wood, roots, leaves, and organic, degradable material.
3. Stones or rock fragments over 7.5 cm (3 inches) in any dimension.
4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.
5. Ice, snow, frost, or frozen soil particles.

The Contractor shall submit for approval product data and the name of the supplier for the proposed clean fill within 10 days of receipt of the Notice to Proceed.

2.7 SAMPLE CONTAINERS

Representative soil samples shall be placed in air-tight liter size plastic containers or bags and labeled with the project name, date of sample, well number and depth at which the sample was taken. The container shall be labeled in permanent indelible ink. Sample containers shall be placed in partitioned cardboard boxes. Boxes shall be labeled with project number and well number. Containers and boxes shall be furnished by the Contractor.

2.8 CONDITION OF PRODUCTS

All products used to construct the wells, including well screens and casings, well sealants, and clean fill shall be new and shall arrive on site free from oil, grease, mud, soil, dust, residues and other potential contaminants. The Contracting Officer will reject products that do not meet the above criteria, and order that they be replaced with products that do meet the criteria.

PART 3 EXECUTION

3.1 PROTECTION OF EXISTING CONDITIONS

Maintain existing survey monuments and wells, and protect them from damage from equipment and vehicular traffic. Repair any items damaged during this work. Reinstall wells requiring replacement due to Contractor negligence according to these specifications. Prior to excavation, obtain written approval from the local utility companies and Contracting Officer to drill at each site, to avoid disturbing buried utilities.

3.2 PREPARATION

3.2.1 Decontamination Before Mobilization

The Contractor shall clean all drilling, pumping equipment and all equipment and tools that enter the borehole at its shop before mobilizing to the site using high-pressure hot water/steam to remove residual oil and grease, mud, soil cuttings, residues and potential contaminants. The Contracting Officer will inspect the drilling equipment upon its arrival at the Project Site, and if it is inadequately cleaned, the Contracting Officer shall order that the equipment be removed from the site until the equipment is adequately cleaned.

3.2.2 Decontamination on Site

During drilling and well installation operations, the Contractor shall stage all well materials, drilling tools and casings on wooden beams, so they will not come in contact with the ground. Materials, tools and casings that come in contact with the ground shall be washed with high-pressure hot water/steam.

3.2.3 Disinfection During Construction

The Contractor shall chlorinate all drilling and pumping equipment that will come in contact with the native soils to minimize the potential for the introduction of bacteria into the aquifer. The Contractor shall mix chlorine with clean water at a strength of 50 parts per million to make a proper solution. The Contractor may apply the chlorine solution using a spray canister or other suitable means. In addition, the Contractor shall periodically chlorinate water used during the drilling process. All permanent construction materials, including well casings, and well screens shall also be chlorinated on-site prior to installation to minimize the potential for introduction of bacteria. Contracting Officer shall review and approve all proposed chlorination procedures in advance with Contractor.

3.2.4 Temporary Roadways

If necessary, the Contractor shall construct temporary roadways and staging areas using heavy rubber matting, wooden timbers or wooden planks to support the drilling rig and support vehicles, as necessary. The ground surface at the well locations may be soft and may not be capable of supporting this equipment during rainy conditions and whenever the temperatures are above freezing.

3.2.5 Water Source

The well drilling/installation requires the use of water. Prior to its use at the site, the water source shall be sampled and tested, and approved by the Contracting Officer for the constituents specified in the Water Quality Analysis Table provided at the end of this section of specifications. Submit drilling water source analytical test results, no more than 10 working days before beginning drilling operations. The Contractor is responsible for locating the source, obtaining the water from the source, transporting it to, and storing it at the site.

3.3 WELL CONSTRUCTION

3.3.1 Drilling Methods

Drilling shall be done using direct-rotary or reverse-circulation drilling methods with drilling fluid, or other means acceptable to the Contracting Officer. Drilling fluids and/or temporary casings shall be introduced into the borehole to maintain borehole stability. The Contractor shall mix and recirculate drilling fluids in mud tubs (sedimentation tanks). Use of mud pits must be approved by Contracting Officer.

The Contractor's Drilling Fluids Engineer shall monitor the drilling fluid system continually in accordance with the approved Drilling Fluids Program to assure that the fluid properties meet the specifications. This monitoring shall be done during the drilling of the final borehole, and during well construction and development.

3.3.2 Soil Sample Collection

Soil samples shall be obtained from a depth of 150 to 300 feet below ground by means suitable to the Contracting Officer. Soils shall be sampled in five-foot increments or at a change in stratum.

Upon completion of the boreholes, the Contractor shall submit to the Contracting Officer for review and approval, a Proposed Well Construction Diagram for each permanent well. The diagram shall be a profile, having a vertical scale showing the following:

1. The diameter and depth of the boreholes for the permanent wells, including any temporary well casings, proposed well seal, and well-screen design.
2. A detailed geologic log extending from the top of the borehole to the bottom of the borehole, including the 50% grain size for soils subjected to grain-size analysis.
3. Static water level, date of measurement, and measurement reference (top of casing and ground surface).

3.3.3 Borehole for Well Construction

The borehole shall be 36 inches in diameter. A temporary well casing of 30 inches in diameter shall be installed from the ground surface to a depth of 30 feet. The borehole diameter from 30 to 300 feet shall be 30 inches in diameter. If additional temporary well casings are proposed, these proposed casing diameters and depths shall be proposed in the Well Installation Plan and approved by the Contracting Officer, prior to mobilizing to the site.

The Contractor shall maintain the vertical plumb of the borehole. The method of determining vertical plumb shall be approved in advance with the Contracting Officer. The borehole shall not deviate more than 2 inches horizontally per 100 feet vertically.

Well drilling equipment shall remain on site at all times during the drilling of the borehole.

3.3.4 Permanent Well Casing

The top of the permanent 24-inch diameter well casing shall extend approximately 3 feet above ground (or as directed by the Contracting Officer).

Permanent casing shall be joined together by means of butt welding, using methods and welding materials, as approved by Contracting Officer.

Stainless steel guides of the appropriate diameter shall be welded to the outside of the well casing to center the casing in the borehole.

The Contractor shall be responsible for maintaining vertical plumb throughout the construction of each well. Permanent well casing(s) shall not deflect from a vertical plumb line more than 2 inches per 100 vertical feet of casing.

The Contractor shall measure the plumbness of the permanent 24-inch diameter well casing when it is first installed, before the well seal is installed, and after the seal is installed. The Contracting Officer shall be present at all times when a well is being measured for plumbness.

3.3.5 Grain size Analysis of the Formation

Representative samples of the natural soil formations shall be obtained at five-foot intervals or change in stratum from 150 to 300 feet. Contractor shall collect two (2) sets of soil samples - one (1) for Contractor's use, and one (1) for the Contracting Officer. Samples shall be collected in one liter heavy-duty plastic storage containers.

The soil samples collected from the borehole shall be subjected to grain-size analysis in accordance with ASTM C136/C136M. The Contractor shall provide summary sieve analysis data sheets, grain-size distribution curves, and samples for all native-formation materials collected from a depth of 150 to 300 feet. The grain-size distribution curves shall be displayed on graphs showing cumulative percent retained versus grain size in inches and mm. Grain-size distribution curves shall be submitted to the Contracting Officer for review within 7 days after the soil sampling.

The Contractor shall not discount the volume of coarse soil material (1/4-inch diameter and greater) but instead shall weigh the coarse fraction and report the weight on the grain-size distribution curves.

1. The Contractor shall submit a well-screen submittal indicating the material of construction, strength, slot size, open area per foot of screen, and transmitting capacity per foot of screen at an entrance velocity of 0.1 feet per second.

3.3.6 Well Screen

Once the borehole is complete, 24-inch diameter well screen shall be joined to the bottom of the 24-inch diameter stainless steel well casing and lowered into the well. The entire well screen assembly shall include the screen, a stainless steel bottom plate and concrete slab anchored to the bottom plate.

Stainless steel guides shall be welded to the bottom and top of the well screen to center the well screen in the borehole.

The Professional Engineer is responsible for reviewing the summary sieve analysis data sheets, grain-size distribution curves, and confirming that the specified 80-slot screen size is appropriate for the formation being screened. If the 80-slot screen is determined to not be appropriate, the Professional Engineer is responsible for specifying an appropriate slot size and/or artificial filter pack (if recommended by Contractor) to prevent fines from entering the well at the conclusion of well development. The grain-size distribution curves, recommended slot size and artificial filter pack (if recommended by Contractor) and any analysis are to be submitted to the Contracting Officer for review within 7 days after the soil sampling.

Repercussions for the failure to submit the grain-size distribution curves, recommended slot size and artificial filter pack (if recommended by Contractor to the Contracting Officer will be the responsibility of the Contractor.

3.4 WELL DEVELOPMENT

The well shall be developed in accordance with the Well Installation Plan, by approved methods. Developing equipment shall be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. Development shall be performed using only mechanical surging, over pumping, or jetting, or a combination thereof in accordance with ASTM D5521/D5521M. Details of the proposed development method shall be included in the Well Installation Plan. Development shall be conducted to achieve a stable well of maximum efficiency.

Each permanent well shall be developed at increasing rates up to a maximum of 3,000 gpm.

Well development shall continue until the water is free of drilling fluids, sand, silt and turbidity when pumping at 3,000 gpm. Well water shall be clear to the unaided eye and turbidity levels shall be less than or equal to 1 NTU. The discharge shall be diverted into a container that will collect all the sand being carried by the water. Development of the well is satisfactory if the amount of sand collected is less than 0.5 gallon per 100,000 gallons (0.5 ppm) of water pumped at the specified rate. Development of the well is satisfactory if the amount of sand collected is less than 0.5 gallons per 100,000 gallons (0.5) ppm of water pumped at the specified rate through the Rossum Sand Tester at pumping rate of 0.5 gpm. Upon completion of the test the amount of sand in the well shall be determined using a Rossum Sand Tester to verify that no material is being deposited in the bottom of the well.

The flow rate shall be measured using an approved orifice weir placed at the end of the temporary discharge line about 1,600 feet from the well, or using a magnetic flow meter.

3.5 PERFORMANCE TESTS

3.5.1 Performance Pumping Tests

3.5.1.1 Pumping Test Procedures

The Contractor shall furnish all labor, tools, materials and equipment; and perform all operations in connection with the performance testing of eight (8) permanent water-supply wells, which includes, but is not limited to providing and subsequently removing a temporary pumping unit; a temporary power supply(s) capable of powering all equipment simultaneously; discharge pipeline; flow measurement equipment; water-sampling equipment; labor and materials for continuous monitoring of pumping equipment during performance testing and for reading and recording drawdown and recovery water levels during and after the continuous capacity pumping tests.

Upon completion of the permanent wells, the Contractor shall conduct a performance pumping test of each permanent well for a period of 24 hours, as specified, when approved by the Contracting Officer. The permanent wells shall be pumped at a minimum rate of 3,000 gpm and/or as directed by the Contracting Officer.

The Contractor's pumping equipment, including the submersible pump, the discharge piping, stilling well and any other equipment that enters the wells, shall arrive on site free of oil, grease, soil, residues and other contaminants. Any equipment that arrives on site that is not clean shall be removed from the site immediately and properly cleaned.

The Contractor shall test his pumping equipment 24 hours prior to the commencement of each performance test to ensure that the pumping equipment is properly functioning, that pump output is satisfactory, that sampling taps are properly functioning and suitable to the Contracting Officer, that the temporary discharge piping is free of significant leaks, and that flow measurement equipment is measuring the flow correctly. The Contractor shall correct any defects observed. The Contracting Officer will not authorize the commencement of any performance test until all defects have been corrected.

Prior to initiating any performance test, the Contractor shall chlorinate the permanent wells and pumping unit with a chlorine solution that will result in a chlorine level of 50 parts per million. At the end of the performance test, a sample of the water shall be taken and delivered to an approved laboratory for bacteriological analysis. In the event that bacteria is detected, the Contractor shall re-chlorinate and analyze samples as many times as is necessary to obtain negative bacteria results, at no additional cost to Owner.

During each performance test, the Contractor shall keep pumping test records of the pumping rates, weather conditions, rainfall, drawdown and recovery in the permanent well and all observation wells selected by the Contracting officer during the respective pumping and recovery periods. All water-level readings shall be measured using electronic probes and recorded to the nearest hundredth of a foot (measuring tapes are to read directly in feet, tenths and hundredths of a foot). In addition to the actual time of each water level reading, the Contractor shall record the number of minutes that have elapsed from the start of a test. Water level readings shall be taken according to the following timetable:

1. Prior to startup of test (static water level)
2. After 30 seconds
3. One minute to 10 minutes: once every minute
4. Ten minutes to 100 minutes: once every 10 minutes
5. One hundred minutes to 4 hours: once every 30 minutes
6. Four hours to 12 hours: once every hour
7. Twelve hours to shut down: once every 2 hours
8. Prior to shutdown of test.

At the beginning of each performance test and during each two (2) hour reading, the Contractor shall measure and record the flow of water in gallons per minute.

After the pump is shut off, the Contractor shall measure water-level recovery at the same frequency as specified above for the pumping phase.

For the start of any performance test (first 100 minutes) and shutdown (first 100 minutes), the Contractor shall provide two (2) qualified individuals to measure and record the water level in the well and one other well selected by Contracting Officer.

Performance tests shall be initiated on a Monday, Tuesday, Wednesday, or Thursday only, as approved by Contracting Officer, due to the water quality sampling protocol required for the Project. No drilling, development or pumping of other wells shall be permitted 24 hours prior to, during or 24 hours after the pumping test unless authorized by the Contracting Officer.

At the conclusion of each pumping test, a 24-inch diameter cap shall be welded over the top of the well casing for protection.

3.5.1.2 Pumping Equipment

Pumps and motors used for performance testing shall be of good quality, reliable and capable of pumping continuously throughout the test period except for necessary interruptions for adjustments that may be required. Said interruptions shall not exceed one-half (1/2) hour at any one time or more than 3% of the entire time from the beginning of a test to the end. If shutdowns or interruptions due to any cause exceed the specified limits, and a test is declared to be a failure by Contracting Officer, the Contractor shall start a new performance test without receiving compensation for the test declared to be a failure. Performance testing shall not commence until such time as approved by Contracting Officer.

Electrical generators used to power the pumps shall be of good quality, reliable and capable of generating power continuously. Generators shall be equipped with a noise reduction system and secondary containment for fuel as specified and approved by Contracting Officer. In addition, the Contractor shall place heavy duty sheet plastic, properly bermed, beneath each electrical generator to provide additional secondary containment of fuel, subject to the approval of Contracting Officer.

The Contractor shall provide for the entire duration of any performance test an auxiliary pump and motor ready for immediate use if trouble should develop with the primary pumping unit.

3.5.1.3 Discharge Pipeline and Flow Measurement

The Contractor shall provide a temporary discharge pipeline, approximately 1,600 feet in length, to extend from the well being pumped to a concrete

lined box culvert, which discharges to Sansing Lake. Refer to section 3.4.1 of the Aquifer Pump Test Geotechnical Data Report (Golder Associates, 2016).

The discharge line shall be properly sized to carry a flow of up to 3,000 gpm to the point of discharge. It is the intent of Contracting Officer to have the water discharged at a point where it will not flow through the ground and back into the well being pumped and influence the drawdown readings of the well being tested.

The pumping rate shall be measured using a properly calibrated magnetic flow meter capable of measuring flow rates of at least 3,000 gpm. A calibration record will be required to demonstrate the flow meter accuracy. The flow meter shall be placed within 15 meters of the well.

Alternatively, the pumping rate may be measured using an approved and properly sized orifice weir placed at the end of the discharge pipeline, with a rigid 1-1/4-inch plastic sight glass and appurtenances, to measure the head on the orifice so that the pumping rate may be accurately computed. The rigid sight glass shall have the proper fittings so that it is in the vertical position at all times. A rigid measuring tape shall be permanently attached to the sight glass.

The Contractor shall provide a gate valve within 25 feet of the well to allow for adjustments to the pumping rate. A water sampling apparatus shall be provided at the wellhead of each well. The apparatus shall be made of steel, stainless steel and/or PVC. Brass fixtures, including "lead free brass" shall not be allowed. The apparatus shall have a "tee" and two separate sampling taps, each with a valve. One sampling tap shall be a smooth-nosed stainless steel faucet to be used for laboratory samples. The other tap shall have a barbed fitting for samples tested in the field.

Splashboards, plastic sheeting, hay bales or a combination of these materials shall be used to ensure that no erosion occurs as pumped water is discharged and flows to Sansing Lake. Erosion control devices shall be maintained throughout the performance tests.

3.5.1.4 Pumping Test Records

Within two days after the conclusion of the pumping tests, the Contractor shall submit pumping test records typed or neatly handwritten in black ink on a standard form that includes in the heading: the date of the pumping test, well identification and location; and the Contractor's name, address, and telephone number. The heading shall also include information on the pumping equipment, the discharge line and the flow measurement equipment. Below the heading, records shall be done in chart form showing the actual time (date, hour and minute), the elapsed time (in minutes) from the beginning of a test; the static water levels, and water level drawdown and recovery readings (in feet, tenths and hundredths of a foot) in the pumped well and observation wells; the pumping rate(s) (in gallons per minute); the orifice head (in inches); weather conditions; rainfall; and any pertinent observations or occurrences.

The Contractor shall submit a blank copy of the pumping test record in advance of the pumping tests for review and approval by the Contracting Officer.

3.5.2 Test for Plumbness and Alignment

Upon completion of the permanent well, plumbness and alignment shall be tested by lowering into the well, to the total depth of the well, a plumb 40 (forty) feet long. The outer diameter of the plumb shall not be more than 1/2 inch smaller than the inside diameter of the well casing being tested. If the plumb fails to move freely throughout the length of the casing or well screen for the depth of well or should the well vary from the vertical in excess of two-thirds the inside diameter of that part of the well being tested for each 100 feet of depth, the plumbness and alignment of the well shall be corrected. If the faulty alignment and plumbness is not correctable, as determined by the Contracting Officer, the well shall be abandoned as specified in paragraph WELL OR PILOT HOLE ABANDONMENT and a new well drilled at no additional cost to the Government.

3.5.3 Test for Quality of Water

At the conclusion of each permanent water supply well pumping test, the Contractor shall secure samples of the water in suitable containers, and of sufficient quantity, to have bacterial, physical, and chemical analyses made by a recognized testing laboratory certified by the state of Alaska. Water Quality Analysis shall address each item specified in Table 1 - Water Quality Analysis Table **AM#9...is attached at the end of this section....AM#9** Expenses incident to these analyses shall be borne by the Contractor and the results of the analyses shall be furnished to the Contracting Officer. All sampling and analyses shall be performed using USEPA and State approved methods, procedures, and holding times.

3.5.4 Video Inspection

At the conclusion of the performance test, Contractor shall perform a video inspection of each water-supply well to establish its as-built condition. The inspection shall be done in the presence of the Contracting Officer. The Contracting Officer will examine the walls of the well casing and the well screen.

The video camera and equipment shall have a color monitor for field viewing, and shall be recorded in color on DVD. In addition, the camera shall be capable of being articulated to view in the downward and sideward directions. The camera shall have a built-in depth counter to monitor depth in the field and record depth on the DVD image.

The Contractor shall submit one (1) copy of the DVD of the video inspection to the Contracting Officer.

3.5.5 Sand Test

As part of each performance pumping test, a determination of the amount of sand (formation material) a well is producing shall be performed. Prior to starting the sand test all material shall be removed from the bottom of the well. Test each well by pumping at a rate of at least 3,000 gpm sufficient to produce approximately 25 feet of draw-down. After the pump is at the desired pumping rate the flow from the discharge shall be diverted into a Rossum Sand Tester. Development of the well is satisfactory if the amount of sand collected is less than 0.5 gallon per 100,000 gallons (0.5 ppm) of water pumped at the specified rate. Upon completion of the test the amount of sand at the bottom of the well screen shall be determined to verify that no material is being deposited in the bottom of the well.

3.6 DISINFECTING

After installation of the temporary pump and after each pumping test, the wells shall be disinfected by adding chlorine, conforming to AWWA B301, or hypochlorite, conforming to AWWA B300, in sufficient quantity so that a concentration of 50 ppm of chlorine shall be obtained in all parts of the well. Chlorine solution shall be prepared and introduced into the well in an approved manner and shall remain in the well for period of at least 12 hours but not more than 24 hours. Information on methods for preparing chlorine solution and introducing it into the well may be found in AWWA C654. After the contact period, the well shall be pumped until the residual chlorine content is not greater than 1.0 ppm. The well shall be pumped to waste for an additional 15 minutes with less than 1 ppm chlorine residual after which two samples shall be taken not less than 30 minutes apart and tested for the presence of coliform bacteria. The well shall be disinfected and reinfected as may be required until two consecutive samples of water are found upon test to be free of coliform bacteria.

3.7 SITE CLEAN-UP

After completion of the work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work. Excavation and vehicular ruts shall be backfilled and dressed to conform with the existing landscape. Utilities, structures, roads, fences, or any other pre-existing item which must be repaired or replaced due to the Contractor's negligence shall be the Contractor's responsibility; repair or replacement shall be accomplished prior to completion of this contract.

3.8 DOCUMENTATION AND QUALITY CONTROL REPORTS

Establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

Test reports shall be submitted for: Grain-Size Distribution Curves, Well Development Records, Plumbness and Alignment, Quality of Water, Pumping Test Records, Video Inspection, As-Built Drawings, Abandonment Records, Project Photographs, Water Source, Artificial Filter Pack, and Performance Tests.

Certificates shall be submitted for: Well Casings, Drilling Mud, Well Screens, and Construction of the Artificial Filter Pack.

3.8.1 Borehole Logs

A borehole log shall be completed for each boring drilled. Borehole logs shall be prepared by the Professional Engineer present onsite during all well drilling and installation activities. Copies of complete borehole logs shall be kept current in the field at each well site and shall be available at all times for inspection by the Contracting Officer. Final borehole logs shall be submitted to the Contracting Officer within 3 days of completion of each borehole. Information provided on the logs shall include, but not be limited to, the following:

- a. Name of the project and site.
- b. Boring/well identification number.

- c. Location of boring (coordinates, if available).
- d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.
- e. Date boring was drilled.
- f. Reference data for all depth measurements.
- g. Name of driller and name and signature of Professional Engineer preparing log.
- h. Nominal hole diameter and depth at which hole diameter changes.
- i. Total depth of boring.
- j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Information such as rod size, bit type, pump type, pilot-hole diameter, etc., shall be recorded. A description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use shall be included. If measured, mud viscosities and weight shall be recorded.
- k. Depth of each change of stratum. If location of strata change is approximate, it shall be so stated.
- l. Description of the material of which each stratum is composed, in accordance with ASTM D2488. Soil parameters for logging shall include, but shall not be limited to, classification, depositional environment and formation, if known, Unified Soil Classification Symbol, secondary components and estimated percentages, color, plasticity, consistency (cohesive soil), density (non-cohesive soil), moisture content, structure and orientation, and grain angularity. Classification shall be prepared in the field at the time of sampling. The results of visual observation of the material encountered, and any unusual odor detected shall also be duly noted and recorded.
- m. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.
- n. Depth to water and date measured before, during, and after each drilling shift, and prior to well installation.
- o. Box or sample number. Depths and the number of the core boxes and/or samples shall be recorded at the proper interval.

3.8.2 Installation Diagrams

The well will not be accepted until the borehole logs and installation diagrams are received. Submit As-built drawings for each well installed, prepared by the Professional Engineer present during well installation operations, within 10 working days of the completion of the well installation procedure. The diagram shall illustrate the as-built condition of the well and include, but not be limited to, the following items:

- a. Name of the project and site.

- b. Well identification number.
- c. Name of driller and name and signature of the Professional Engineer preparing diagram.
- d. Date of well installation.
- e. Description of material from which the well is constructed, including well casing/riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, generalized soil description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground), if used.
- f. Total depth of well.
- g. Nominal hole diameter.
- h. Depth to top and bottom of screen, and filter pack.
- i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).
- j. Type of cement and/or bentonite used, mix ratios of grout, method of placement and quantities used.
- k. Elevations/depths/heights of key features of the well, such as top of well casing/riser pipe, top and bottom of protective casing (if used), ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.
- l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.
- m. Well location by coordinates. A plan sheet shall also be included showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.
- n. Static water level upon completion of the well.
- o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.
- p. Description of surface completion.

3.8.3 Well Development Records

A well development record shall be prepared for each well, and submitted to the Contracting Officer within three working days of the completion of development under the supervision of the Professional Engineer present during well installation operations. Information provided on the well development record shall include, but not be limited to, the following:

- a. Date, time, and depth of water level in the well, before development.

- b. Depth to bottom of well, name of project and site, well identification number, and date of development.
- c. Method used for development, to include size, type and make of equipment, bailer, and/or pump used during development.
- d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.
- e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.
- f. Volume of water added to the well, if any.
- g. Volume (i.e. gallons) and physical character of sediment removed, to include changes during development in color, and odor.
- h. Source of any water added to the well.
- i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements. Sand content.
- j. Total depth of well and the static water level as in accordance with ASTM D4750 from top of the casing, immediately after pumping/development, and 24 hours after development.
- k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.
- l. Name and job title of individual developing well.

3.8.4 Well Abandonment Records

Abandonment records shall be submitted to the Contracting Officer within three days of abandonment of each well, and include, as a minimum, the following:

- a. Project name.
- b. Well or test hole number.
- c. Well/boring location, depth and diameter.
- d. Date of abandonment.
- e. Method of abandonment.
- f. All materials used in the abandonment procedure and the interval in which test materials were placed.
- g. Casing, and or other items left in hole by depth, description, and composition.
- h. Description and total quantity of grout used initially.
- i. Description and daily quantities of grout used to compensate for settlement.

- j. Water or mud level (specify) prior to grouting and date measured.
- k. The reason for abandonment of the well/test hole.

3.8.5 Project Photographs

Before, during, and after completion of work, take a minimum of three (3) views of each well installation. Photographs shall be 3 by 5 inch color prints. The photographs shall be mounted and enclosed back-to-back in a double face clear plastic sleeve punched to fit standard three ring binders. Each color print shall show an information box, 1-1/2 by 3-1/2 inches. The box shall be typewritten and arranged as follows:

Project No.	Contract No.
Contractor/Photographer:	
Photograph No.	Date/Time
Description:	
Direction of View:	

-- End of Section --